

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
3 May 2001 (03.05.2001)

PCT

(10) International Publication Number  
**WO 01/30882 A1**

(51) International Patent Classification: C08G 63/668,  
C09D 7/00

(74) Agents: FAWKES, David, Melville et al.: Intellectual  
Property Group, Avecia Limited, Hexagon House, P.O. Box  
42, Blackley, Manchester M9 8ZS (GB).

(21) International Application Number: PCT/GB(X)/03592

(22) International Filing Date:  
19 September 2000 (19.09.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
9925416.1 28 October 1999 (28.10.1999) GB

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,  
DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR,  
HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR,  
LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ,  
NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM,  
TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian  
patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European  
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,  
IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG,  
CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

(71) Applicant (*for all designated States except US*): **AVECIA  
LIMITED** [GB/GB]; Hexagon House, Blackley, Manches-  
ter M9 8ZS (GB).

(72) Inventors; and

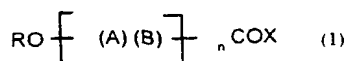
(75) Inventors/Applicants (*for US only*): **THETFORD,  
Dean** [GB/GB]; P.O. Box 42, Hexagon House, Blackley,  
Manchester M9 8ZS (GB). **BARNETT, Stuart** [GB/GB];  
Hexagon House, P.O. Box 42, Blackley, Manchester M9  
8ZS (GB).

**Published:**

— With international search report.

*For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.*

(54) Title: POLYESTER ASSOCIATION THICKENERS



less than 80% by weight polyethyleneglycol such as polyethyleneglycol with number average MW from 200 to 35,000; B is the residue of C<sub>4-50</sub>-alk(en)yl succinic acid such as C<sub>14</sub>-alkylsuccinic acid; X is hydroxy, a group ROA-, a group -OR<sup>1</sup>, -NHR<sup>1</sup> or -O<sup>-</sup>M<sup>+</sup>, R<sup>1</sup> is C<sub>1-18</sub>-alk(en)yl; M<sub>+</sub> is a metal cation, and n is from 2 to 100.

(57) Abstract: A polyester of general formula (1) and its use as Association Thickener in aqueous media such as paints and inks; wherein R is hydrogen or a polymerisation terminating group; A is a residue of a poly-C<sub>2-6</sub>-alkyleneglycol containing not

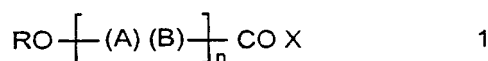
## POLYESTER ASSOCIATION THICKENERS

The present invention relates to novel polyesters derived from polyethyleneglycols (hereinafter PEG) and alk(en)ylsuccinic anhydrides (hereinafter ASA) and their use as "Association Thickeners" in aqueous based coatings such as paints and printing inks. Many of these polyesters are believed to function according to the "Micellar Bridging" theory.

The terms "Association Thickener" and "Micellar Bridging" are explained in US 4,426,485 and refer to the manner by which the hydrophobic parts (hereinafter hydrophobe) of a water-soluble thickener are absorbed by a solute particle such as a latex particle to provide a network of low molecular weight thickener molecules giving good flow and levelling characteristics to water borne coatings and latex systems under high shear conditions.

Association Thickeners, including thickeners which function by Micellar Bridging theory, generally contain hydrophobes which are spaced either randomly or in clusters along a hydrophilic, especially water soluble, polymer backbone. It has now been found that polyesters which exhibit Association Thickening can be conveniently prepared by polymerising a hydroxy polyethylene alk(en)yl succinate carboxylic acid (herein after HPASCA) where the alk(en)yl hydrophobe may be distributed randomly or in clusters along the polyester backbone chain.

According to the invention there is provided a polyester of general formula 1



wherein

R is hydrogen or a polymerisation terminating group;

A is the residue of poly-C<sub>2-6</sub>-alkyleneglycol containing not less than 80% by weight polyethyleneglycol;

B is the residue of C<sub>4-50</sub>-alk(en)ylsuccinic acid;

the repeat unit represented by -(A)(B)- may be the same or different;

X is hydroxy, a group ROA-, a group -OR<sup>1</sup>, -NHR<sup>1</sup> or -O<sup>+</sup>M<sup>+</sup>;

R<sup>1</sup> is C<sub>1-18</sub>-alk(en)yl;

M<sup>+</sup> is a metal cation; and

n is from 2 to 100.

The Polyester Association Thickeners of formula 1 are hereinafter referred to as PAT's.

For clarity, the residues A and B are linked via an ester group -O-CO- formed between a terminal hydroxy group of the poly(C<sub>2-6</sub>-alkyleneglycol) and a carboxylic acid group of alk(en)ylsuccinic acid or its anhydride.

It is to be understood that the repeat units  $-(A)(B)-$  of the polyester chain may contain the same or different residues A and/or the same or different residues B.

However, it is much preferred that the polyester contains different residues represented by A and/or different residues represented by B. These different residues represented by A and B may be randomly or sequentially distributed along the polyester backbone chain. It is much preferred that the residue represented by B is sequenced in the polyester backbone chain since this results in clusters of the hydrophobes which aids Micellar Bridging. This sequencing of B is readily achieved by varying the residue A.

When R is a polymerisation terminating group it is preferably  $C_{1-20}$ -alkyl, more preferably  $C_{1-10}$ -alkyl, even more preferably  $C_{1-6}$ -alkyl and especially  $C_{1-4}$ -alkyl, for example, methyl.

Preferably, R is hydrogen.

When A is the residue of a poly- $C_{2-6}$ -alkylene glycol containing not less than 80% by weight polyethylene glycol it is preferably a polyalkylene glycol containing ethylene oxy (EO) and propylene oxy (PO) groups. It is particularly preferred that A contains not less than 90% and especially not less than 95% by weight polyethylene glycol.

When A contains both EO and PO groups, it is preferred that the PO groups occupy a central position in the polyether moiety i.e. EO PO EO.

When A is polyethylene glycol it may consist of two polyethylene glycol chains linked together by a linking compound via urethane or ester groups. Examples of suitable linking compounds are dicarboxylic acids or anhydrides such as succinic anhydride, maleic anhydride and phthalic anhydride or di-isocyanates such as 1,6-hexane di-isocyanate and tolyl di-isocyanate.

It is much preferred, however, that A is the residue of polyethylene glycol and that the number average molecular weight of the polyethylene glycol is preferably from 200 to 35,000.

Examples of suitable polyethylene glycols are PEG 200, PEG 1500, PEG 2000, PEG 3000, PEG 4000, PEG 6000, PEG 8000, PEG 10,000 and PEG 35,000 wherein the numbers signify approximate number average molecular weight.

Preferably, the alk(en)yl group in residue B contains not greater than 30 and especially not greater than 20 carbon atoms. It is also preferred that the alk(en)yl group contains not less than 8 and especially not less than 12 carbon atoms since this aids Micellar Bridging. The alk(en)yl group may be linear or branched. Examples of alk(en)yl groups are 2-octenyl, octadecanyl, n-decyl, n-decenyl, n-tetradecyl, n-hexadecyl, n-octadecyl, dodecenyl and polyisobutylene.

Preferably, X is hydroxy or a group  $O^+M^+$ . It is to be understood that  $M^+$  can be a monovalent, divalent or trivalent cation. When  $M^+$  represents a di- or tri-valent cation it forms a salt with two or three anions derived from the polyester of formula 1. Examples of suitable cations are ammonium, quaternary ammonium, benzalkonium, pyridinium,

cetyl pyridinium, amine (primary, secondary and tertiary), alkali metal (especially sodium, potassium or lithium) and alkaline earth (especially barium, calcium and magnesium) including mixtures thereof.

Preferably, X is hydroxy.

It is preferred that n is not greater than 70, more preferably not greater than 50 and especially not greater than 30.

The number average molecular weight of the polyester of formula 1 can vary over a large range depending on the size of the hydrophobes and the length of the poly-C<sub>2-6</sub>-alkylene glycol chain residue. Nonetheless, it is preferred that the number average molecular weight does not exceed 100,000.

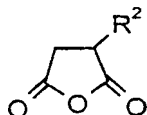
The acid value of the polyester of formula 1 wherein X is hydroxy is preferably less than 25, more preferably less than 15, even more preferably less than 10 and especially not greater than 5 mg KOH/g. Particularly useful thickeners have been obtained which exhibit an acid value between 0.5 and 3 mg KOH/g.

The polyesters of formula 1 may be conveniently prepared by polymerising one or more HPASCA's of formula 2



wherein A and B are defined hereinbefore.

The HPASCA of formula 2 itself is obtainable by reacting a poly C<sub>2-6</sub>-alkylene glycol with an alk(en)ylsuccinic acid or preferably its anhydride (hereinafter ASA) of formula 3 in the presence of a base as catalyst and preferably in an inert atmosphere.



3

wherein

R<sup>2</sup> is C<sub>4-50</sub>-alk(en)yl which may be linear or branched.

Examples of ASA's are 2-octen-1-ylsuccinic anhydride, octadecenylsuccinic anhydride, n-decylsuccinic anhydride, n-decenylsuccinic anhydride, n-tetradecylsuccinic anhydride, n-hexadecylsuccinic anhydride, n-octadecylsuccinic anhydride, dodecenylsuccinic anhydride and poly isobutylenesuccinic anhydrides (hereinafter PIBSA).

The ASA's and PIBSA's of formula 3 are well known and can be made by any processes known to the art. Some of these processes are summarised in US 4,749,500.

The reaction between the poly C<sub>2-6</sub>-alkylene glycol and the ASA is preferably carried out at a temperature between 150 and 250°C and especially between 170 and 190°C.

The base is preferably soluble in the reactants and can be a tertiary aliphatic amine, aromatic amine or pyridine derivative. Bases which are non-volatile under the reaction conditions are preferred since the equipment required does not need to be adapted to contain the base. The preferred base is 4-(N,N-dimethylamino) pyridine.

5 The inert atmosphere may be provided by any of the inert gases of the Periodic Table according to Mendeleev and is especially nitrogen.

The PAT's are prepared by heating one or more HPASCA's of formula 2 at between 180 and 200°C in an inert atmosphere and preferably in the presence of an esterification catalyst such as tetra-alkyl titanate, for example tetrabutyl titanate, zinc salt of an organic acid, for example zinc acetate, zirconium salt of an aliphatic alcohol, for  
10 example zirconium isopropoxide, an aromatic acid such as toluene sulphonic acid or a strong aliphatic organic acid such as haloacetic acid, for example trifluoroacetic acid. Zirconium-n-butylate is the preferred catalyst.

When the PAT is prepared from one or more HPASCA's in a single reaction the  
15 resultant PAT consists of a polyester backbone chain wherein the hydrophobes are randomly located along the polyester chain.

However, it is also possible to sequence the hydrophobes by either polymerising one HPASCA and then reacting the resultant polymer with a different HPASCA or even a polymerised different HPASCA. This sequencing of the hydrophobes along the polyester  
20 backbone chain is an important feature of the invention since it results in clusters of the hydrophobe which aids Micellar Bridging.

Whereas it is possible to use any number of different HPASCA's to make the PAT it has been found that there is no advantage in using more than four different HPASCA's or homopolymers derived therefrom. Preferred PAT's are derivable from only the two  
25 different HPASCA's or homopolymers derived therefrom.

When the PAT contains a polymerisation terminating group R it may be conveniently prepared by reacting the final polymer containing a terminal hydroxy group with an organic moiety containing a functional group which reacts with the hydroxy group. Examples of such organic moieties are alkyl halides, di-alkylsulphates and aromatic and  
30 aliphatic carboxylic acids. When the polymerisation terminating group is alkyl, it is possible to form an alkyl end-capped HPASCA by reacting a poly C<sub>2-4</sub>-alkylene glycol mono alkyl ether with an ASA. The resultant end-capped HPASCA may then be subsequently reacted with a HPASCA containing the same or different unit AB. The use of poly C<sub>2-6</sub>-alkylene glycol mono alkyl ethers is less preferred since polymerisation is  
35 restricted to only one end of the HPASCA.

When the PAT contains the group -OR' or -NHR', these may be prepared under similar condition used to polymerise the HPASCA by reacting the terminal carboxylic group with an alcohol R'-OH or an amine H<sub>2</sub>N-R'. When the reaction involves an amine H<sub>2</sub>N-R', the esterification catalyst is not required. However, as noted hereinbefore, it is

preferred that the PAT contains a terminal hydroxy group, i.e. X is hydroxy or a group -O<sup>-</sup>M<sup>+</sup>.

As noted hereinbefore the PAT's act as Association Thickeners in aqueous formulations such as aqueous based dispersions of particulate solids, millbases, paints and printing inks including inks used in drop-on-demand printers. Many of these polymers also function by Micellar Bridging. The PAT's can also be used to thicken aqueous dispersions and emulsions of latices, especially acrylic latices. The amount of PAT is generally less than 5%, preferably less than 3% and especially less than 1% based on the total weight of the aqueous formulation.

Thus, according to a further aspect of the invention there is provided a composition comprising water and a PAT.

There is also provided a paint or ink comprising a pigment, dispersant, water, a film-forming binder and a PAT.

The PAT may be used to thicken any aqueous or emulsion system such as aqueous coating compositions for the paper, leather and textile industries, oil well flooding compositions and drilling muds, detergents, adhesives, waxes, polishes, cosmetics and toiletries, topical pharmaceutical formulations and pesticidal or agricultural compositions for control of insects, rodents, fungi, bacteria, parasites and plant growth regulating compositions.

Toiletries includes personal care formulations which can be oil-in-water and water-in-oil formulations such as shampoos, bath gels, hair gels, hand creams, hand lotions, bath lotions, cleansing creams, hair creams and the like.

The invention is further illustrated by the following non-limiting examples whereby all references are to parts by weight unless expressed to the contrary. In these examples, the numerical value following PEG indicates the number average molecular weight of the polyethylene glycol and the length of the carbon chain attached to succinic anhydride is indicated, e.g. C<sub>16</sub>-ASA.

#### Example 1 Random Hydrophobe (PEG 8000/C<sub>16</sub>-ASA)

Polyethylene glycol (100 parts PEG 8000, 0.0125M ex. Fluka) was stirred under a flow of nitrogen at 180°C and then 4-N,N-dimethylamino pyridine (0.1 part, 1% based on weight of PEG 8000 ex. Aldrich) and hexadecylsuccinic anhydride (4.05 parts, 0.0125M ex. Tokyo Chemical Industries) were added. The reactants were stirred for 2.5 hours at 180°C under nitrogen to form the PEG 8000/C<sub>16</sub>-ASA monomer. Zirconium butylate (1 part, 1% on weight of PEG 8000 ex. Fluorochem) was then added and polymerisation effected by stirring for 16 hours under nitrogen, when the polymer exhibited an acid value of 1.16 mg KOH/g. After cooling, the polymer was obtained as an off-white solid. This is Thickener 1.

**Example 2** Random Hydrophobe (PEG 6000/C<sub>14</sub>-ASA)

This was prepared in identical manner to Thickener 1 of Example 1 except using PEG 6000 (100 parts, 0.016M ex. Fluka) and n-tetradecylsuccinic anhydride (4.94 parts, 0.016M ex. TCI) in place of the PEG 8000 and hexadecylsuccinic anhydride. The resultant polymer exhibited an acid value below 3 mg KOH/g. This is Thickener 2.

**Examples 3 to 7** Random Hydrophobes**Table 1**

Example	Thickener	PEG	ASA	Acid Value (mg KOH/g)
3	3	2000	C <sub>18</sub> -ASA	0
4	4	3000	C <sub>18</sub> -ASA	1.36
5	5	4000	C <sub>18</sub> -ASA	0
6	6	6000	C <sub>18</sub> -ASA	0.75
7	7	8000	C <sub>18</sub> -ASA	2.69

**Example 8** Clustered Hydrophobe (PEG 10,000/C<sub>12</sub>-ASA)(PEG 200/C<sub>12</sub>-ASA)<sub>3</sub>**a)** PEG 10,000/C<sub>12</sub>-ASA

PEG 10,000 (100 parts, 0.01M ex. Fluka) was stirred at 200°C under a flow of nitrogen and 4-N,N-dimethylamino pyridine (0.1 part) and n-dodecylsuccinic anhydride (2.68 parts, 0.01M ex. TCI) were added. Stirring was continued at 200°C for 2 hours under nitrogen. This is Intermediate 1.

**b)** (PEG 200/C<sub>12</sub>-ASA)<sub>3</sub>

PEG 200 (20 parts, 0.1M ex. Fluka) was stirred under a flow of nitrogen at 200°C and then 4-N,N-dimethylamino pyridine (0.1 part) and n-dodecylsuccinic anhydride (26.84 parts, 0.1M ex. TCI) were added. The reactants were stirred for 2 hours under nitrogen to form the PEG 200/C<sub>12</sub>-ASA monomer. Zirconium butylate (0.5 parts) was then added and polymerisation affected by stirring at 200°C under nitrogen for a further 2 hours. The acid value of the polymer was 46.25 mg KOH/g indicating an average of three hydrophobes in the polyester chain. This is Intermediate 2.

**c)** Intermediate 1 (73.7 parts, 0.007M) and Intermediate 2 (10 parts, 0.007M) were stirred under nitrogen at 200°C and then zirconium butylate was added (0.8 parts). The reaction was continued by stirring for 20 hours under nitrogen at 200°C when the polymer exhibited an acid value of 2.92 mg KOH/g. This is Thickener 8.

**Example 9** Random Mixed Hydrophobes (PEG 8000/C<sub>18</sub>-ASA/C<sub>14</sub>-ASA)

This was prepared in identical manner to Thickener 1 of Example 1 except using n-octadecylsuccinic anhydride (2.19 parts, 0.0063M, ex. TCI) and n-tetradecylsuccinic anhydride (1.85 parts, 0.0063M, ex. TCI) in place of the hexadecylsuccinic anhydride. The product exhibited an acid value of 1.85 mg KOH/g. This is Thickener 9.

**Example 10** Random Mixed Hydrophobes (PEG 8000/C<sub>18</sub>-ASA/C<sub>16</sub>-ASA)

This was again prepared in identical manner to Thickener 1 of Example 1 except using n-octadecylsuccinic anhydride (2.19 parts, 0.0063M ex. TCI) and n-hexadecylsuccinic anhydride (2.02 parts, 0.0063M) in place of the amount of n-hexadecylsuccinic anhydride used in Example 1. The resultant polymer exhibited an acid value of 2.04 mg KOH/g. This is Thickener 10.

**Examples 11 to 17**

A white millbase was prepared by milling together an anionic dispersant (2.46 parts Disperse AYD W-22 ex Daniel Products, USA) defoamer (0.32 part Dehydran 1293 ex Henkel) titanium dioxide (43.0 parts Tioxide TR-92 ex Tioxide Ltd) and water (15-63 parts) on a Red Devil shaker for 45 minutes in the presence of 3mm glass beads (125 parts). The beads were then removed and the millbase was let down into an acrylic resin (Neoresin XK 90 ex Avecia Ltd) at a ratio of 1:1.75 (w/w) millbase:acrylic resin.

An Association Thickener was then dissolved in a 2:1 mixture of hexyleneglycol and water to give a 35% (w/w) solution. An aliquot was then added to the above white acrylic paint to give 0.05 parts thickener in 10 parts white paint. The viscosity of the resultant paint was measured using a Bohlim V88 viscometer equipped with a 20° cone/15mm plate diameter. The results are given in Table 2 below.

**Table 2**

Thickener 1 (Example 11) *			Thickener 2 (Example 12)		
Time(s)	Shear Rate (1/S)	Viscosity (Pas)	Time(s)	Shear Rate (1/S)	Viscosity (Pas)
11.1	38.09	9.481	11.2	38.06	0.904
21.6	101.8	6.853	21.0	101.8	0.588
29.8	175.0	5.576	29.3	175.2	0.529
37.1	294.7	4.743	37.2	295.1	0.463
44.2	487.4	3.628	45.0	487.9	0.396
51.5	830.1	2.247	53.0	830.9	0.341
59.6	1396	1.257	61.6	1397	0.290
67.9	2372	0.648	70.1	2374	0.239

Thickener 3 (Example 13)			Thickener 4 (Example 14)		
Time(s)	Shear Rate (1/S)	Viscosity (Pas)	Time(s)	Shear Rate (1/S)	Viscosity (Pas)
11.2	38.07	1.732	11.3	38.0	0.279
21.0	101.8	0.279	21.1	101.8	0.138
29.4	175.3	0.144	29.3	175.2	0.102
37.3	295.1	0.101	37.2	295.1	0.090
45.0	487.9	0.062	45.0	487.9	0.066
53.0	830.9	0.045	52.9	830.9	0.059
61.4	1397	0.030	61.5	1397	0.046
69.6	2374	0.024	70.5	2374	0.040

Thickener 5 (Example 15)			Thickener 6 (Example 16)		
Time(s)	Shear Rate (1/S)	Viscosity (Pas)	Time(s)	Shear Rate (1/S)	Viscosity (Pas)
11.2	38.04	0.301	11.2	38.05	0.833
21.0	101.8	0.218	21.0	101.8	0.650
29.3	175.2	0.184	29.3	175.2	0.513
37.2	295.1	0.152	37.2	295.1	0.387
45.0	487.9	0.115	44.9	487.9	0.284
52.9	830.9	0.093	52.8	830.9	0.207
60.6	1397	0.070	61.2	1397	0.142
69.8	2374	0.056	69.8	2374	0.099

Thickener 7 (Example 17)		
Time(s)	Shear Rate (1/S)	Viscosity (Pas)
11.2	38.08	1.859
21.0	101.8	1.289
30.0	175.3	0.993
37.9	295.1	0.740
45.8	487.9	0.518
53.7	830.9	0.355
62.2	1397	0.234
71.3	2374	0.150

\* Footnote to Table 2

Example 11 contains 0.06 parts Thickener 1.

**Example 18 to 38** Random Hydrophobes with single PEG

Example 1 was repeated using different polyethyleneglycols with differing number average molecular weight (PEG) and different alk(en)yl succinic anhydride derivatives (ASA) to give the PAT's indicated in Table 3 below. In the table, the ratio of PEG to ASA is 1:1 and the number of carbon atoms in the alkyl chain of the ASA is as indicated. The descriptor (ene) indicates that the alkyl chain is unsaturated.

**Table 3**

Example	Thickener	Structure	Mn of PEG	alk(en)yl chain length of ASA	Acid value (mg KOH/g)
18	11	1500/C <sub>12</sub> (ene)	1500	C <sub>12</sub> (ene)	2.22
19	12	2000/C <sub>12</sub>	2000	C <sub>12</sub>	5.51
20	13	3000/C <sub>12</sub> (ene)	3000	C <sub>12</sub> (ene)	1.86
21	14	4000/C <sub>12</sub> (ene)	4000	C <sub>12</sub> (ene)	1.64
22	15	6000/C <sub>12</sub> (ene)	6000	C <sub>12</sub> (ene)	4.0
23	16	8000/C <sub>12</sub>	8000	C <sub>12</sub>	4.58
24	17	3000/C <sub>18</sub> (ene)	3000	C <sub>18</sub> (ene)	1.36
25	18	4000/C <sub>18</sub> (ene)	4000	C <sub>18</sub> (ene)	0
26	19	6000/C <sub>18</sub> (ene)	6000	C <sub>18</sub> (ene)	0.75
27	20	4000/C <sub>16</sub>	4000	C <sub>16</sub>	2.64
28	21	6000/C <sub>16</sub>	6000	C <sub>16</sub>	2.0
29	22	8000/C <sub>14</sub>	8000	C <sub>14</sub>	1.34
30	23	4000/C <sub>18</sub>	4000	C <sub>18</sub>	0
31	24	8000/C <sub>18</sub> (ene)	8000	C <sub>18</sub> (ene)	2.69
32	25	2000/C <sub>18</sub> (ene)	2000	C <sub>18</sub> (ene)	0
33	26	4000/C <sub>8</sub> (ene)	4000	C <sub>8</sub> (ene)	0
34	27	8000/C <sub>12</sub>	8000	C <sub>12</sub>	0
35	28	1500/C <sub>12</sub>	1500	C <sub>12</sub>	1.66
36	29	1500/C <sub>12</sub>	1500	C <sub>12</sub>	0
37	30	3000/C <sub>8</sub>	3000	C <sub>8</sub>	1.21
38	31	6000/C <sub>12</sub>	6000	C <sub>12</sub>	1.84

**Examples 39 to 44** Random Hydrophobes with mixed PEG

Example 1 was again repeated but using mixtures of polyethleneglycols with differing number average molecular weights as indicated in Table 4 below wherein the molar ratio of the PEG's and ASA is as indicated.

**Table 4**

Example	Thickener	Structure	Molar Ratio of PEG1/PEG2/ASA	Acid Value (mg KOH/g)
39	32	12000/200/C <sub>14</sub>	1:1:2	6.38
40	33	10000/600/C <sub>14</sub>	1:4:5	1.97
41	34	10000/600/C <sub>14</sub>	1:4:5	0
42	35	12000/200/C <sub>14</sub>	1:1:2	0
43	36	10000/600/C <sub>14</sub>	1:7:8	2.21
44	37	10000/600/C <sub>14</sub>	1:3:4	1.46

**Examples 45 to 51 Clustered Hydrophobes**

Example 8 was repeated using different polyethyleneglycol/ASA intermediates to obtain the thickeners having clustered hydrophobes indicated in Table 5 below.

**Table 5**

Example	Thickener	Intermediate I	Intermediate II	Molar Ratio of Int. I to Int. II	Acid Value (mg KOH/g)
45	38	10000/C <sub>10</sub>	(200/C <sub>10</sub> ) <sub>4</sub>	1:1	2.63
46	39	10000/C <sub>12</sub>	(300/C <sub>12</sub> ) <sub>5</sub>	1:1	2.73
47	40	10000/C <sub>14</sub>	(600/C <sub>14</sub> ) <sub>6</sub>	1:1	1.76
48	41	10000/C <sub>14</sub>	(400/C <sub>14</sub> ) <sub>7</sub>	1:1	0
49	42	10000/C <sub>12</sub>	(400/C <sub>12</sub> ) <sub>17</sub>	1:1	1.99
50	43	10000/C <sub>14</sub>	(C200/C <sub>14</sub> ) <sub>4.2</sub>	1:1	2.68
51	44	10000/C <sub>14</sub>	(200/C <sub>14</sub> ) <sub>4</sub>	1:1	2.83

\*Footnote to Table 5

The numeric values in the column headed Intermediate II indicates the number of repeat units of PEG/ASA monomer.

**Example 52 Symmetrical Hydrophobe (PEG 1000/C<sub>14</sub>)<sub>9</sub> (PEG 35000) (PEG 1000/C<sub>14</sub>)<sub>9</sub>****a) (PEG 1000/C<sub>14</sub>)<sub>9</sub>**

Polyethyleneglycol Mn 1000 (50.59 parts, 0.05m ex Fluka) was added to a mixture of 4-N,N-dimethylaminopyridine (0.1 parts, ex Aldrich) and n-tetradecyl succinic anhydride (15 parts, 0.05M ex TCI) at 200°C under nitrogen. The reactants were stirred for 2 hours at 200°C. Zirconium n-butylate (0.5 parts) was added and the reaction

continued by stirring under nitrogen at 200°C for a further 18 hours. The polymer had an Acid Value of 4.77 mg KOH/g.

b) Title Polymer

5 Polyethyleneglycol Mn 35000 (29.75 parts, 0.85 mM ex Fluka) was added to the polymer from (a) (20 parts, 1.70 mM) and the reactants were stirred under nitrogen at 200°C when zirconium n-butyrate (0.5 parts) was added. The reaction was continued by stirring under nitrogen at 200°C for 48 hours when the reaction mix became very viscous. After cooling, the product was obtained as a white solid with an Acid Value of 1.34 mg  
10 KOH/g. This is Thickener 45.

Examples 53 to 71

Examples 11 to 17 were repeated except that the viscosity of the white paints containing 0.5% w/w thickener was measured on the Bohlin V88 Viscometer using a 2.5°  
15 cone/15mm plate diameter. The results are given in Table 6 below.

Table 6 - Viscosity (Pas)

Example	Time (Secs)	11.1	21.6	29.8	37.1	44.2	51.5	59.6	67.9
	Shear Rate (1/s)	38	102	175	295	487	829	1395	2370
	Thickener								
53	12	0.170	0.052	0.031	0.017	0.002	0.003	0.004	0.003
54	13	0.169	0.055	0.030	0.020	0.011	0.015	0.011	0.010
55	14	0.231	0.058	0.036	0.022	0.018	0.019	0.014	0.013
56	15	0.168	0.095	0.057	0.038	0.028	0.028	0.021	0.020
57	17	0.279	0.138	0.102	0.090	0.066	0.059	0.046	0.037
58	18	0.301	0.218	0.184	0.152	0.115	0.093	0.070	0.056
59	19	0.833	0.650	0.513	0.387	0.284	0.207	0.142	0.100
60	20	1.237	0.897	0.756	0.612	0.459	0.335	0.231	0.152
61	21	0.618	0.479	0.408	0.329	0.254	0.198	0.144	0.104
62	22	1.146	0.926	0.807	0.718	0.635	0.562	0.489	0.403
63	23	0.433	0.272	0.206	0.164	0.112	0.087	0.066	0.052
64	24	1.859	1.289	0.993	0.740	0.518	0.355	0.234	0.150
65	25	1.732	0.279	0.144	0.101	0.062	0.045	0.030	0.024
66	26	0.095	0.027	0.041	0.035	0.025	0.024	0.024	0.018
67	27	0.014	0.038	0.016	0.013	0.006	0.007	0.007	0.006
68	33	5.305	2.643	1.829	1.270	0.906	0.651	0.461	0.325
69	38	1.946	1.096	0.787	0.558	0.392	0.277	0.190	0.126
70	39	2.377	1.477	1.067	0.760	0.526	0.371	0.252	0.173
71	40	3.757	2.289	1.678	1.231	0.893	0.657	0.480	0.343

Examples 72 to 79

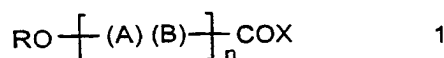
The viscosity of 5% w/w solutions of thickener in water at 20°C was measured using a rheometer supplied by TA Instruments, model CSL<sup>2</sup> 500HR fitted with a 4cm parallel steel plate set at a 250μ gap. The results are given in Table 7 below.

**Table 7**  
**Viscosity (Pas)**

Example	Thickener	Time		45.5	60.1	74.8	79.7	94.3	108.9	113.7	118.6
		Shear rate (1/s)									
72	34			14.8	39.54	105.5	145.5	388.2	1024	1419	1961
				30.56	10.38	4.29	3.40	1.87	1.50	1.20	0.94
73	35			1.76	1.64	1.53	1.50	1.33	1.05	0.94	0.83
74	41			52.16	19.72	7.12	5.01	1.76	0.81	0.63	0.49
75	42			8.63	8.92	9.07	8.54	3.87	1.55	0.75	0.77
76	36			70.43	21.63	6.18	4.34	1.20	0.47	0.36	0.29
77	37			63.11	13.06	4.63	2.22	0.86	0.41	0.30	0.23
78	43			27.11	12.84	6.44	5.20	2.82	1.57	1.28	1.03
79	44			18.37	9.08	4.77	3.91	2.24	1.32	1.12	0.93

CLAIMS

1. A polyester of general formula 1



wherein

R is hydrogen or a polymerisation terminating group;

A is the residue of poly-C<sub>2-6</sub>-alkyleneglycol containing not less than 80% by weight polyethylene glycol;

B is the residue of C<sub>4-50</sub>-alk(en)yl succinic acid;

the repeat unit represented by -(A)(B)- may be the same or different;

X is hydroxy, a group ROA-, a group -OR', -NHR' or -O<sup>+</sup>M<sup>+</sup>;

R' is C<sub>1-18</sub>-alk(en)yl;

M<sup>+</sup> is a metal cation; and

n is from 2 to 100.

2. A polyester as claimed in claim 1 wherein the polyester contains different residues represented by A and/or different residues represented by B.

3. A polyester as claimed in claim 2 wherein B is sequenced in the polyester backbone chain to give clusters of hydrophobes attached to B.

4. A polyester as claimed in any one of claims 1 to 3 wherein R is hydrogen.

5. A polyester as claimed in any one of claims 1 to 4 wherein A is the residue of polyethylene glycol.

6. A polyester as claimed in claim 5 wherein the number average molecular weight of the polyethylene glycol is from 200 to 35,000.

7. A polyester as claimed in any one of claims 1 to 6 wherein the alk(en)yl group of the residue of succinic acid represented by B contains not less than 12 and not greater than 20 carbon atoms.

8. A polyester as claimed in any one of claims 1 to 7 wherein n is not greater than 30.

9. A polyester as claimed in any one of claims 1 to 7 wherein the number average molecular weight of the polyester is not greater than 100,000.

10. A polyester as claimed in any one of claims 1 to 7 wherein the acid value of the polyester wherein X is hydroxy is between 0.5 and 3 mg KOH/g.

11. A method of preparing a polyester as claimed in claim 1 which comprises polymerising a compound of formula 2 in the presence of an esterification catalyst and in an inert atmosphere.

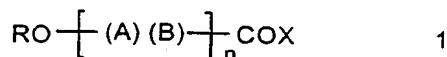


wherein

A is the residue of poly-C<sub>2-6</sub>-alkylene glycol containing not less than 80% by weight polyethylene glycol; and

B is the residue of C<sub>4-50</sub>-alk(en)yl succinic acid.

12. The use of a polyester of formula 1



as a thickener in aqueous formulations

wherein

R is hydrogen or a polymerisation terminating group;

A is the residue of poly-C<sub>2-6</sub>-alkyleneglycol containing not less than 80% by weight polyethylene glycol;

B is the residue of C<sub>4-50</sub>-alk(en)yl succinic acid;

the repeat unit represented by -(A)(B)- may be the same or different;

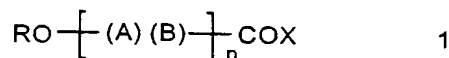
X is hydroxy, a group ROA-, a group -OR', -NHR' or -OM\*;

R' is C<sub>1-18</sub>-alk(en)yl;

M\* is a metal cation; and

n is from 2 to 100.

13. A composition comprising water and a polyester of formula 1



wherein

R is hydrogen or a polymerisation terminating group;

A is the residue of poly-C<sub>2-6</sub>-alkyleneglycol containing not less than 80% by weight polyethylene glycol;

B is the residue of C<sub>4-50</sub>-alk(en)yl succinic acid;

the repeat unit represented by -(A)(B)- may be the same or different;

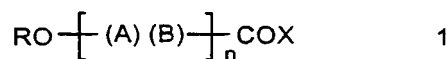
X is hydroxy, a group ROA-, a group -OR', -NHR' or -O<sup>+</sup>M<sup>+</sup>;

R' is C<sub>1-18</sub>-alk(en)yl;

M<sup>+</sup> is a metal cation; and

n is from 2 to 100.

14. A paint or ink comprising water, pigment, dispersant, film-forming binder resin and a polyester of formula 1



wherein

R is hydrogen or a polymerisation terminating group;

A is the residue of poly-C<sub>2-6</sub>-alkyleneglycol containing not less than 80% by weight polyethylene glycol;

B is the residue of C<sub>4-50</sub>-alk(en)yl succinic acid;

the repeat unit represented by -(A)(B)- may be the same or different;

X is hydroxy, a group ROA-, a group -OR', -NHR' or -O<sup>+</sup>M<sup>+</sup>;

R' is C<sub>1-18</sub>-alk(en)yl;

M<sup>+</sup> is a metal cation; and

n is from 2 to 100.

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/03592

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 C08G63/668 C09D7/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C08G C09D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, CHEM ABS Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 659 492 A (JAHNKE, RICHARD W.) 21 April 1987 (1987-04-21) claims 1,2,12; example 1 column 1, line 8 - line 20	1,4,7,9, 12,13
A	US 4 749 500 A (FORSBERG, JOHN W. ET AL) 7 June 1988 (1988-06-07) cited in the application claims 1,2,11; examples 5,6 column 1, line 14 - line 27	1,4-7, 12,13
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 02, 30 January 1998 (1998-01-30) & JP 09 272796 A (MITSUI TOATSU CHEM INC), 21 October 1997 (1997-10-21) abstract	1,5-9, 12,13
--- -/--		

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \* & \* document member of the same patent family

Date of the actual completion of the international search

15 December 2000

Date of mailing of the international search report

19/01/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.  
Fax: (+31-70) 340-3016

Authorized officer

Krische, D

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/03592

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 008 146 A (ICI LTD) 31 May 1979 (1979-05-31) claims 1-3; example 1 page 1, line 73 - line 94 ---	1,5-7,13
A	WO 98 37957 A (ICI PLC) 3 September 1998 (1998-09-03) claims 1,11; examples SE1,29,40,A45 ---	1,5-7, 12,13
A	DATABASE CHEMABS 'Online! CHEMICAL ABSTRACTS SERVICE, COLUMBUS, OHIO, US; retrieved from STN Database accession no. 127:53108/DN, HCAPLUS XP002155582 abstract & KEYANPOUR, M. ET AL.: IRAN. J. POLYM. SCI. TECHNOL. (PERSIAN ED.), vol. 9, no. 1, 1996, pages 17-21, -----	1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/03592

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4659492	A	21-04-1987	AU 3931385 A CA 1230331 A EP 0187756 A ES 540380 D ES 8801362 A IN 162587 A IT 1200078 B MX 164376 B PT 80045 B PT 80045 A WO 8600081 A ZA 8500978 A	10-01-1986 15-12-1987 23-07-1986 16-12-1987 01-03-1988 11-06-1988 05-01-1989 06-08-1992 17-06-1987 01-04-1985 03-01-1986 30-10-1985
US 4749500	A	07-06-1988	US 4661275 A AT 56039 T AU 595226 B AU 6144186 A BR 8606842 A CA 1272477 A CN 86106154 A,B DE 3673802 D DK 156587 A EP 0231287 A ES 2001046 A FI 871355 A IN 166860 A JP 8003110 B JP 63500725 T MX 163698 B NO 871306 A WO 8700856 A ZA 8605667 A	28-04-1987 15-09-1990 29-03-1990 05-03-1987 03-11-1987 07-08-1990 27-05-1987 04-10-1990 27-03-1987 12-08-1987 16-04-1988 27-03-1987 28-07-1990 17-01-1996 17-03-1988 15-06-1992 27-03-1987 12-02-1987 25-03-1987
JP 09272796	A	21-10-1997	NONE	
GB 2008146	A	31-05-1979	CA 1122095 A US 4216114 A	20-04-1982 05-08-1980
WO 9837957	A	03-09-1998	AU 6301598 A BR 9807759 A CN 1248927 T EP 0963245 A	18-09-1998 22-02-2000 29-03-2000 15-12-1999

**THIS PAGE BLANK (USPTO)**